Wavefront Control in a Shaped-Pupil Coronagraph: First Results from the Princeton Testbed

Ruslan Belikov (rbelikov at princeton.edu)
Amir Give'on
Laurent Pueyo
Eric Cady
Jason Kay
Michael Carr
N. Jeremy Kasdin

Direct imaging of extrasolar planets, and terrestrial planets in particular, is an exciting but difficult problem requiring a telescope imaging system with unprecedented levels of contrast. One promising design is the Shaped Pupil Coronagraph (SPC), pioneered by our lab over the past several years. The SPC was designed to achieve 10^10 contrast at an inner working angle of 4 lambda/D, based on the requirements of NASA's space-based Terrestrial Planet Finder Coronagraph (TPF-C) mission. However, it has long been recognized that a key problem in achieving these requirements in practice is estimation and control of wavefront aberrations in the optics of the telescope, and doing so over a broad spectral band. In earlier work, we have described the manufacture and test of the SPC on our testbed at Princeton, reaching of 10^5 contrast at 4 lambda/D in air without any wavefront control, as well as reaching almost 10^8 contrast in vacuum with wavefront control on JPL's testbed. In this work, we show the first results of performing wavefront control on our testbed. We have utilized a 32x32 deformable mirror manufactured by the Boston Micromachines Corporation. The corrections were tested at several wavelengths and in white light, improving contrast by more than a factor of 10. We discuss the contrast limiting factors and propose ways of beating them. The main limiting factor currently is the resolution of the electronics, and we project that 10^7 or 10^8 contrast is possible at 4 lambda/D before our air environment is the main limit.